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FOREST INSECT SURVEY

LASSEN NATIONAL FOREST AND ADJACENT PRIVATE LANDS

SEASONS OF 1949 AND 1950

By

E. T. Engen

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Forest Insect Laboratory
29 Forestry Bldg., U. C.
Berkeley 4, California
December 28, 1950

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INTRODUCTION

Each year since 1930, the Berkeley Forest Insect Laboratory, Bureau of Entomology and Plant Quarantine, has conducted a bark-beetle survey of the timber lands comprising the Lassen National Forest and adjacent private lands for the purpose of obtaining information concerning the nature and character of insect-caused tree mortality and to advise the timber-managing agencies as to the needs for control. The scope and intensity of the annual insect survey has varied directly with the funds and manpower available for such work, the nature of known, or potential, destructiveness on the part of several tree-killing insects, and the possibility of controlling any infestation that might be found. For the most part, forest insect survey activities in the past years have been concentrated in the Eastern Lassen, Susanville, and Burney Areas, inasmuch as these large bodies of commercial timber have suffered heavy depletion by bark beetles and are of greatest concern to federal, state and private owners. Surveys to detect insect outbreaks have also been maintained throughout the Westside Lassen Area, but seldom were losses in this portion of the National Forest sampled by plot measurements. Topographic viewing and general reconnaissance usually were sufficient to detect

incipient forest insect outbreaks and to formulate plans for control. Subsequent to each annual insect survey, detailed reports were prepared giving the measured amount of insect-caused tree mortality on established sample plots, estimates of total drain throughout the unit areas, and pointing out conditions where control was needed. In all cases, surveys were concentrated in virgin stands and only a small amount of sampling was conducted in the cutover reserve.

The Lassen National Forest and adjacent private timberlands vary considerably in stand composition, tree species and site, and are particularly different as to problems related to successful control of insect pests. The Eastern Lassen Area, the Susanville Area, and the Burney Area are predominantly "eastside types" of pure ponderosa and Jeffrey pine, with some incense cedar and white fir at higher elevations. The westside Lassen Area is a mixed conifer type forest with sugar pine and ponderosa pine the commercially predominant species.

Most of the previous reports of annual forest insect conditions on the Lassen National Forest have been made for specific reporting areas, particularly the eastside pine types. It is felt that continuity of reporting can best be served by segregating reporting areas, namely: (1) Eastern Lassen and Susanville Areas, (2) Burney Area, and (3) Westside Lassen Area. Until more uniform reporting areas can be established in the Westside Lassen Area, present loss conditions are presented in this report by regional delineations of timber-management working circles. (See the appended map).

LASSEN NATIONAL FOREST AND ADJACENT TIMBERLANDS

FIELD EXAMINATION:

1949

Personnel: Gilbert A. Ward, Thomas G. McElroy, Boyd Wickman and E. T. Engen, Forest Insect Laboratory, Bureau of Entomology and Plant Quarantine, 29 Forestry Building, U. C., Berkeley 4, California.

Date: June 20 to September 7, October 3 to October 7, 1949.

1950

Personnel: Robert Chambers, Stanley Hoyt, Robert Stevens, Marius Wasbauer and S. G. Merryman.

Date: June 19 to August 15, October 19 and 20, 1950.

Method: Insect-caused tree mortality measured on roadside sample strips, half-section plots and trail strips. Intensive ground and air reconnaissance supplemented plot measurements.

EASTERN LASSEN AND SUSANVILLE AREAS

AREAS EXAMINED

Measurement of current insect-caused loss was made on 6,626 acres of sample plots and strips representative of the 266,300 acres of remaining virgin pine stands in the 617,350 acres of timber-producing lands of the Eastern Lassen and Susanville Areas. In addition, post-cutting mortality was measured on 2,965 acres of sample plots and strips in stands cut by sanitation-salvage methods. Ground and aerial reconnaissance provided coverage of other cutover reserve stands and furnished the basis for appraising current insect conditions on these lands.

CONDITIONS ENCOUNTERED DURING THE COURSE OF THE SURVEYS

The heaviest timber losses encountered during the course of the surveys occurred in virgin stands, as is normally the case, but some tree mortality was also prevalent in cutover reserve. Bark beetles and other cambium-mining insects were responsible for the majority of all trees killed, but low winter temperatures during 1948-1949 caused some killing of young trees along the edges of open flats. In many instances, lightning had struck trees prior to the time insects had made their attacks, although only a small percentage of the total loss occurred in this category. Windthrown trees were noted only in a few instances. On most parts of the reporting areas, killing of Jeffrey pine by the Jeffrey pine beetle showed an increase in 1948 over the low level of loss that has been sustained in this tree species for the past several years. Jeffrey pine loss in 1949 was slightly below that of 1948, but well above the past average loss for this species in the Eastern Lassen Area. Ponderosa pine mortality was not generally severe in 1948 or 1949 compared to previous years, but locally, in the entomological units along the western boundary of the Eastern Lassen reporting area, ponderosa pine loss was approaching epidemic proportions. The loss situation in ponderosa pine was found to be most critical on the bench west of the Butte Creek Rim in the Nigger Spring reporting unit.

Evidence of defoliating insect work, believed to be spruce budworm on white fir, was found at the higher elevations in the Bogard Buttes unit. Damage was light and the situation is not critical at the present time. Limited damage to pole-size ponderosa pine was noted in the vicinity of Willow Springs, as a result of feeding by a species of pine sawfly.

The activity of the sawfly appeared to be extremely localized and presents no problem at present.

AGENTS RESPONSIBLE FOR TREE MORTALITY DURING 1948 AND 1949

Several species of bark beetles and other cambium-mining insects were found attacking and killing the major tree species in all of the areas examined. In addition, an unusual condition of partial top-killing in pine was noted in several areas in, or near, open flats. In this latter instance, large overmature and isolated trees had only the top portions of the crown killed. Examination of some of these trees indicated that insects were not responsible for the killing, although the dead tops contained scattered attacks by Ips oregoni. A similar top-dying condition of ponderosa pine surrounding open flats occurred in the Lassen National Forest in 1947 and Wagener[1/] reported that sudden cold following a mild period during the early spring months might be suspected as responsible for the dieback.

Following is a list of the insect pests responsible for tree mortality as encountered during the course of the surveys:

(1) The western pine beetle, Dendroctonus brevicomis Lec., is the primary insect responsible for the killing of ponderosa pine. A majority of the total timber loss was caused by this forest pest.

(2) The Jeffrey pine beetle, D. jeffreyi Hopk., is the primary species which was found attacking and killing Jeffrey pine. Current loss in this tree species is somewhat greater than has occurred during the past several years.

1/ Wagener, W. W. 1949. Top Dying of Conifers From Sudden Cold. Jour. Forestry 47:49-53.

(3) The mountain pine beetle, D. monticolae Hopk., was often found in association with the western pine beetle in attack on ponderosa pine, but it did not occur in large numbers anywhere. Only an occasional sugar pine was found to be infested by this insect.

(4) Pine engraver beetles, Ips spp., were found attacking and killing both ponderosa and Jeffrey pines. Attacks were usually limited to the upper portions of larger trees although several areas were found where the entire tree of smaller size had been killed.

(5) The California flatheaded borer, Melanophila californica Van Dyke, was found in many of the ponderosa and Jeffrey pines which had been attacked and killed by bark beetles.

(6) The fir engraver beetle, Scolytus ventralis Lec., and the roundheaded fir borer, Tetropium abietis Fall, were found killing white fir. In some cases, considerable top-killing of young firs was caused by the engraver beetle.

(7) A pine defoliator, probably the ponderosa pine sawfly, Neodiprion fulviceps Cress, caused limited damage to young ponderosa pine in a small area. The spruce budworm, Choristoneura fumiferana (Clem.), was apparently the cause of localized white fir defoliation.

CHARACTER OF INFESTATIONS

1948 and 1949 Infestations

For the most part, infestations during 1948 and 1949 were endemic in character and infested trees occurred as singly-killed individuals, and usually were well scattered throughout the forest. Group loss, an early sign of approaching epidemic conditions, was encountered only in local areas and group-kills seldom exceeded five trees in number. Of particular

note was the general low level of loss in the high hazard fringe areas along the northern and eastern portions of the Eastern Lassen Area, and a higher rate of loss in areas of better site quality along the western portion of the reporting areas. The rate of Jeffrey pine loss during 1949 showed a two-fold increase over conditions encountered during 1947, but total current loss has not approached epidemic levels.

1950 Infestations

Data from the 1950 survey indicate that the general pattern and character of the current infestations in the Eastern Lassen Area will parallel the 1949 infestations. However, increasing evidence of epidemic tendencies was noted in ponderosa pine in the western portions of the Nigger Spring-Butte Creek units with the frequent appearance of group-killed trees interspersed among the generally scattered pattern of loss.

TREND OF BARK-BEETLE INFESTATIONS

For the past several years the rate of pine loss resulting from bark-beetle attacks throughout the Eastern Lassen and Susanville Areas has shown a gradual upward trend (Figure 1) from the low point in the infestation in 1944. The measured loss during 1948 and 1949 indicates a general leveling off of the upward trend present since 1944 for most of the reporting areas; however, local aggressive killing in the Nigger Springs and Butte Creek units may denote a resumption of the upward trend established during 1944-1947.

INSECT-CAUSED LOSS ON SAMPLE PLOTS DURING 1948 AND 1949

Each year an inventory is made of tree mortality resulting from insect attacks on the series of sample plots scattered throughout the forested region in order to determine the amount, kind and intensity of insect activity, and to appraise the severity of infestations. A summary

of the plot measurements, the number of trees killed, the board foot volume of loss, and percent stand killed, is given in Table 1. The severity of loss, as indicated by Table 1, was quite variable on the respective samples. Jeffrey pine loss during 1948 and 1949 was noticeably higher than that of 1947. The following tabulation compares the average measured loss for all the plots during the three-year period from 1947 to 1949.

Average Pine Mortality on Sample Plots

Year	Ponderosa Pine		Jeffrey Pine		Total	
	BM/acre	% stand	BM/acre	% stand	BM/acre	% stand
1947	59.0	0.63	8.7	0.19	67.7	0.49
1948	50.4	0.55	16.1	0.38	66.5	0.50
1949	46.6	0.50	14.1	0.35	60.7	0.45

ESTIMATED INSECT-CAUSED LOSSES IN VIRGIN STANDS DURING 1948 AND 1949

The estimated drain of merchantable timber from insect attack is determined by expanding the measured loss from sample plots to the remaining virgin timber in the entomological units sampled by those plots. This expansion of plot losses, carefully tempered with consideration for existing entomological conditions present in the various reporting units, shows bark beetles caused loss estimated at 18 million board feet of merchantable timber in 1948 and 15 million board feet in 1949. The distribution of the tree mortality during 1948 and 1949 on the several entomological units making up the reporting area is given in Table 2.

INSECT-CAUSED LOSS DURING 1950

Tree mortality occurring after the completion of the annual loss survey is not recorded until the plots are recruised the following season. For this reason, the final measurement of loss for 1950 will not be available until the completion of the plot cruises during the 1951 season.

The general trend and intensity of current loss may be appraised, however, through interpretation of the partial 1950 record. These partial records point to an increase in bark beetle-caused loss during 1950 over that sustained during 1949. Aerial reconnaissance conducted in mid-October confirms the presence of the increasing loss rate measured on sample plots. The current rising rate of loss is due, primarily, to increased western pine beetle activity in ponderosa pine.

CONDITIONS IN CUTOVER RESERVE STANDS

In general, current loss conditions throughout the cutover reserve are not severe. Tree mortality is limited primarily to pine attacked by the western pine beetle, or in some cases, to progressive attack by flatheaded borers. Some white fir is being topkilled by fir engraver beetles, but there is no evidence of aggressive killing in the cutover reserve stands.

CONDITIONS ON AREAS CUTOVER BY SANITATION-SALVAGE METHODS

Prior to 1937, the general practice in cutting ponderosa pine in the Eastern Lassen and Susanville Areas was to remove approximately 70 percent of the merchantable green stand. Since 1937, there has been a gradual shift in cutting practices to reserve a higher percentage of the green volume, and in many cases, limit cutting to trees of high risk to insect attack. Because of the change in cutting practice, several plots sampling insect-caused mortality on the areas where 70 percent or more of the stand had been cut were abandoned and, at present, plot measurement of loss in the cutover reserve is being maintained only on areas treated by sanitation-salvage methods. Several other types of selective cuttings are being sampled on the Blacks Mountain Experimental Forest in cooperation with the California Forest and Range Experiment Station.

During 1948 and 1949 plots sampling losses on selectively cut areas totaled 2.965 acres. Plot loss records for 1948 and 1949 indicating the average volume per acre loss for stands cut in this manner are given in Table 3. Current loss sustained in stands treated by selective cuttings is considerably below the rate of loss existing in virgin stands. The benefits of the light cutting as a measure of insect control is indicated by the following comparison of loss on cut areas versus the average mortality in virgin stands throughout the Eastern Lassen and Susanville Areas for 1948 and 1949.

	INSECT-CAUSED LOSS.....BOARD FEET PER ACRE					
	Ponderosa Pine		Jeffrey Pine		Total Loss	
	1948	1949	1948	1949	1948	1949
Virgin Timberlands	50.4	46.6	16.1	14.1	66.5	60.7
Sanitation-salvage Cut Areas	12.3	19.0	0.1	2.7	12.4	21.7

BURNEY AREA

AREAS EXAMINED

A field cruise measuring insect-caused loss was made on 5,000 acres of plots and roadside strips sampling 160,000 acres of virgin timberlands in the respective entomological units of the Burney Area.

INFESTATION CONDITIONS ENCOUNTERED DURING THE COURSE OF THE SURVEY

1948 Infestation

Tree mortality due to bark beetles and other cambium-mining insects was the lowest recorded since the inception of the annual loss measurements in this area. Individual trees widely scattered throughout the virgin stands of the area made up the bulk of insect-caused loss. There was no group-killing observed, and only occasionally were infested trees found in pairs. The highest concentration of total pine loss was found on the Burney Flat unit. The loss rate here was approximately three times as great as that on other units in the reporting area.

Sugar pine loss showed a marked increase over that of previous years with the main concentration of mortality occurring at the higher elevations of the Hat Creek unit.

Some loss was observed in the cutover reserve stands, but incidence of attack was considerably below that sustained in virgin areas.

1949 Infestation

An abrupt upswing in bark beetle activity in the fall months of 1949 raised insect-caused loss on the Burney Area to the highest level recorded during the past three years. Increases in mortality occurred in all pine species, but 84 percent of the total volume killed in the reporting area was in ponderosa pine. The predominant volume of loss was composed of individual trees, generally over-mature and of a high-risk character

distributed uniformly throughout the stand. Sugar pine mortality continued high in the Hat Creek unit and a significant increase was noted in the westside pine of the Goose Valley unit.

1950 Infestation

The 1950 infestation pattern parallels that of the preceding year. Loss is high, but does not show group-killing tendencies. Killed trees are quite evenly distributed throughout the entomological units, ponderosa pine makes up the bulk of the loss found in all the units except at Goose Valley where sugar pine loss is rather severe.

TREND OF BARK-BEETLE INFESTATIONS

Mounting insect activity in 1949 abruptly reversed the low loss level of the previous year and the aggregate timber mortality of all pine species rose 130 percent. White fir mortality rose sharply during this period, also, showing a 350 percent increase over the previous year. Information available at present indicates that the increasing trend manifested in 1949 will level off and remain fairly stable during the current season. The trend of pine loss in the Burney Area for the past 12 years is shown graphically in Figure 2.

INSECT-CAUSED LOSS ON SAMPLE PLOTS DURING 1948 AND 1949

Table 4 summarizes the plot loss measurements for 1948 and 1949, giving the number of trees killed, board foot volume of loss and percent of stand killed for each sample plot cruised. Severity of loss, as indicated by the table, is quite variable on the respective plots, but loss for all timber species in 1949 is consistently above that measured in 1948. In 1948 the highest loss was found in the predominantly pure pine areas on the eastern portion of the reporting area. In 1949 the highest losses were sustained in the mixed conifer type along the western boundary

of the reporting area.

ESTIMATED INSECT-CAUSED LOSS IN VIRGIN STANDS DURING 1948 AND 1949

An expansion of the virgin sample plot loss measurements for 1948 and 1949 to the virgin acreage in the Burney Area for those years shows pine loss totaled 3,379,000 board feet in 1948 and 15,220,000 board feet in 1949. White fir loss for the same years amounted to 673,000 board feet and 3,697,000 board feet respectively. Table 5 summarizes the estimated insect-caused loss occurring in the respective entomological units comprising the Burney Area.

INSECT-CAUSED LOSS DURING 1950

Loss records from the survey in July 1950, augmented by impressions from an aerial reconnaissance in mid-October, indicate the comparatively high rate of loss sustained during 1949 will carry over into 1950 with little or no change. An accurate appraisal of bark-beetle activity and resulting stand depletion during the entire 1950 season will be available at the termination of the 1951 field season.

CONDITIONS IN CUTOVER RESERVE STANDS

Current loss in the cutover reserve is not critical. Infested trees are few in number and the total loss makes up only a small portion of the annual increment. The serious Ips infestations in second growth stands during the period from 1944-1947 have largely subsided.

CONDITIONS IN AREAS CUTOVER BY SANITATION-SALVAGE METHODS

In an apparent reflection of the increased bark beetle activity in virgin stands, insect-caused loss in areas cut by sanitation-salvage methods also increased during the year. Despite this marked upswing, the

rate of loss on selectively cut areas remains well below that sustained on adjacent virgin stands. The effectiveness of sanitation-salvage cutting in reducing bark-beetle losses is particularly apparent throughout the Burney Flat unit where high risk trees were removed from the stand for control purposes during 1946-1948. A comparison of the seasonal loss on these lightly-cut areas and on surrounding virgin stands is given in the following tabulation:

COMPARISON OF INSECT-CAUSED LOSS ON SANITATION-SALVAGE CUT AREAS AND VIRGIN STANDS IN THE BURNEY FLAT UNIT

	Board foot per acre loss				
	1946	1947	1948	1949	4-yr. total
Virgin Timberlands	49.1	62.3	45.6	72.5	229.5
Sanitation-salvage Cut Areas	28.7	13.8	20.9	46.7	110.1

WESTSIDE LASSEN AREA

In past years the annual forest insect survey for the Westside Lassen Area has been primarily an extensive reconnaissance and only a few sample plots were maintained to determine the amount of loss and kind of insect activity present. During 1949 and 1950, several additional plots and strips were established throughout the mixed conifer stands of this area to sample the 135,000 acres of virgin timber. Sample plots now total 2,163 acres and additional plots or strips are planned to insure adequate appraisal of loss for all areas.

The acreage and resource data as given in the tables of this report were obtained from "Forest Survey Release Number Four", 2/ and from the files of the Forest Supervisor's Office at Susanville, California. Unfortunately, some of the data needed for a complete accounting of resources was not available from any known source and, as a result, some of the estimates of total loss for the reporting area may be subject to error.

CONDITIONS ENCOUNTERED DURING THE COURSE OF THE SURVEYS

Insect-caused mortality in the Westside Lassen Area followed the general pattern of loss in most mixed-conifer stands on the west slopes of the Sierra Nevada range; that is, the over-all pine loss increased nearly twofold from 1948 to 1949. However, the upswing was the result of accelerated mountain pine beetle killing of sugar pine rather than a general rise in all tree-killing insect activity. In general, loss was

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2/ Forest Areas, Timber Volumes and Vegetation Types in California, A. E. Wieslander, H. A. Jensen. California Forest & Range Experiment Station. March 1, 1946.

evenly distributed throughout the entire reporting unit with the exception of the Sugar Pine Flat area where loss ran approximately two to five times as high as that sustained on adjacent lands.

AGENTS RESPONSIBLE FOR TREE MORTALITY

Primary tree-killing insects found in the mixed-conifer forests of the Westside Lassen Area are the same species responsible for tree-killing in the predominantly yellow pine stands of the Eastern Lassen, Susanville and Burney Areas. The relative importance of these forest pests is somewhat altered because of the difference in stand composition found on the respective areas. Western pine beetle attacks consistently account for the greatest percentage of total insect-caused loss in eastside stands, whereas, in the westside mixed-conifer stands, mountain pine beetle activity occasionally exceeds that of other forest pests in the destruction of timber volumes and values. This is particularly evident in the loss pattern being currently sustained throughout the Westside Lassen Area.

CHARACTER OF INFESTATIONS

1948 Infestations

Bark beetle-caused loss was of an endemic character over most of the reporting area. It was scattered throughout the forest generally and consisted preponderantly of mature to over-mature ponderosa and sugar pine. Group killing was observed only in the Sugar Pine Flat area north of Mineral and is restricted to the small plateau west and north of Gray's Peak. Some white fir mortality was present in the reporting area, but loss of this species was at a low level. Much loss in white fir occurred in small trees or as top-killed larger individuals.

1949 Infestations

The pattern of bark beetle-caused loss was generally similar to that of 1948. It was evenly spread over the entire reporting area and, with one exception, showed no group-killing tendencies. Group killing of both over-mature and young, vigorous ponderosa and sugar pine trees was present, however, on the Sugar Pine Flat area and resulted in loss of epidemic proportions over a relatively small area. Ponderosa pine loss remained fairly constant, but sugar pine and white fir mortality increased to such an extent that the over-all loss rate for 1949 was double that of 1948.

1950 Infestations

Partial ground records and aerial observations indicate that the character and pattern of current infestations apparently will not change greatly from that observed in 1949. The rapidly increasing rate of loss for sugar pine appears to be leveling off and over-all tree mortality for 1950 will probably not exceed that of 1949.

TREND OF BARK-BEETLE INFESTATIONS

A widespread increase in mountain pine beetle activity throughout the mixed-conifer stands of the Westside Lassen Area caused the trend of loss to climb to almost twice that measured in 1948. Western pine beetle activity in ponderosa pine did not follow the rising trend, but remained fairly constant over the two-year period. Current insect activity indicates that the rate of loss will level off and current infestations will not vary appreciably from those of 1949.

INSECT-CAUSED LOSS ON SAMPLE PLOTS DURING 1948 AND 1949

Newly established sample plots scattered throughout the Westside Lassen Area will be cruised annually to determine the year-to-year drain

of timber resources resulting from insect attack. A summary of the 1948 and 1949 plot measurements giving the number of trees killed, the board foot volume of loss and the average loss per acre is given in Table 7. Loss varies considerably from one year to the next on the respective plots, the over-all averages show little change in ponderosa pine loss and a 360 percent increase in sugar pine mortality in 1949. White fir loss also increased perceptibly during 1949.

ESTIMATED INSECT-CAUSED LOSS IN VIRGIN TIMBER STANDS DURING 1948 AND 1949

On the basis of sample plot measurements, it is estimated that forest insects destroyed approximately 5.2 million board feet of pine in 1948 and 11.6 million board feet in 1949. During the same period white fir loss rose from 0.9 million board feet to 4.0 million board feet. Table 8 contains a breakdown of the estimated timber loss for the three working circles comprising the Westside Lassen Area.

BARK-BEETLE LOSS DURING 1950

The over-all trend and intensity of insect activity during 1950 may be expected to follow the general pattern of loss established in 1949. Ponderosa and sugar pine mortality will apparently approach that of the previous year. However, current indications do not point to a continuation of the rising loss rate measured in 1949. The epidemic loss sustained in the timber stand on the Sugar Pine Flat area appears to be diminishing, but will continue to be higher than loss on adjacent areas during 1950.

LOSS CONDITIONS IN CUTOVER RESERVE STANDS

No serious damage resulting from insect pests was noted during the course of ground or aerial survey. Records of loss from two roadside strips indicate that tree mortality during 1949 amounted to 12.7 board feet per acre.

FACTORS TO BE CONSIDERED IN SUCCESSFUL CONTROL OF BARK BEETLES

The eastside pine stands of the Eastern Lassen, Susanville and Burney Areas of the Lassen National Forest are part of a large, nearly continuous, high value timber type extending east of the Cascade-Sierra Nevada ranges from the Tahoe National Forest in California, north into Canada and east to Montana. These stands are characterized by slow-growing, mature to over-mature timber of high commercial quality that is susceptible to serious bark-beetle epidemics. During severe bark-beetle infestations the loss in one year has amounted to as much as 15 percent of the total green stand, and in some cases, 50 percent of the total timber stand was killed over a five-year period of epidemic conditions (3). As a result of the steady increase in timber values over the past 30 years, it had become increasingly apparent to timber owners and managers that the high annual insect-caused drain was economically intolerable and would eventually threaten the existence of continued logging operations in eastside pine types. Continued heavy loss in stands reserved for eventual cutting would reduce their volume and value to a point where management on a sustained-yield basis would not be possible.

In view of the mounting concern over depletion of ponderosa pine stands in this area by the western pine beetle, and the realization that the protection of stands from insect-caused loss was of paramount importance in the management of timber lands for sustained yield, direct control measures were attempted which employed methods designed to kill bark-beetle brood in infested trees. The various techniques for the direct control of the pine bark beetles employed by private and federal timber-managing agencies in the control projects prior to 1937 included (1) felling the tree, then peeling and burning the brood-laden bark, (2) the use of

"trap trees", which provided attractive bark-beetle breeding conditions, and burning these trees before the developing broods could emerge, (3) solar heat which utilized the sun's energy to produce lethal temperatures in felled, infested trees and (4) salvage logging where infested trees were cut and milled and the infested bark burned in the mill's burner.

The history of control using direct brood-killing methods showed that temporary relief was obtained when applied to a rising trend of infestations; however, the apparent benefits were short-lived and loss on treated areas soon reached the level surrounding untreated areas. Craighead et al (3) summarized the effectiveness of direct control as a measure of reducing bark-beetle infestations in eastside stands and concluded that it is of little value in preventing recurrence of outbreaks over a reasonable period of time.

With the advent of efficient mobile logging equipment which made light cuttings over large areas feasible, it became possible to try control techniques evolved from studies of western pine beetle history and habits that had not been attempted previously because of operational and economic difficulties. The apparent predilection of western pine beetle for slow-growing, decadent trees in ponderosa pine stands had been recognized by many investigators and resulted in the formulation of various selective cutting methods. Person (8) found that the western pine beetle preferred to attack ponderosa pine trees with a diameter growth of less than 1 mm per year and he advocated cutting the slowest growing trees in the stand to improve stand conditions with respect to insect damage and subsequent growth. Keen (6) also proposed selective cuttings which could be used to reduce mortality rates and forestall pine beetle outbreaks in the interior ponderosa pine stands.

The combination of the development of flexible logging equipment and recognition of the western pine beetle's apparent selective attack habit led, in 1937, to the indirect type of control where that portion of the stand particularly susceptible to bark beetle attack was removed in a light-cut logging operation (7), (9). This selective removal of the susceptible element in the stand approached the problem of forest insect control with a basically different concept; rather than destroy the beetle broods directly and obtain a temporary reduction in loss, selective cuttings were designed to remove favorable breeding material from the forest in order to effect a relatively long period of reduced loss through the resulting improved stand conditions.

Bongberg (1) reports 10 years' results of large scale selective cutting tests undertaken at the Blacks Mountain Experimental Forest in Lassen County, California. The tests were designed to measure the insect-control benefits derived by the removal of the high risk trees from ponderosa pine stands. Comparison of loss on an annual basis between uncut areas versus selectively cut areas shows the selective cut resulted in a reduction of insect-caused loss ranging from 67 to 92 percent per year. Cumulative loss reduction over the 10-year period covered by the report amounted to 71 percent. This represents a 394 board foot per acre volume surplus on areas treated by sanitation-salvage methods that presumably would have been destroyed by beetle attack had no light cutting been made.

An opportunity to compare the insect control effectiveness of direct fell-peel-burn control techniques with indirect control methods came about in 1946. At that time maintenance control involving both methods was undertaken against a persistent endemic western pine beetle infestation in the Burney Area, Lassen County, California. Bongberg (2) reports that the

direct control methods were of no benefit in further reducing western pine beetle loss in the stands already sustaining endemic infestation conditions. Sanitation-salvage methods, however, resulted in a 44 percent loss reduction the first year following treatment and a 72 percent reduction the second year.

Other studies have shown that the high-risk trees in the stand will yield lumber grades consistent with the average of the stand as a whole (4). Also, it has been found that the cost of sanitation-salvage logging is increased only slightly over other conventional heavier utilization cuttings (5). As an end result, control of bark beetles through sanitation-salvage cutting permits the utilization of trees which otherwise would be largely lost as a result of attacks by insects. Also, protection against serious beetle-caused mortality is afforded to the reserve stand for a period sufficient to allow for plans and action in silvicultural treatments to promote growth and regulate the stand for sustained yield at full capacity. Consistent with other factors of favorable terrain, area hazard, and economics, sanitation-salvage logging is recommended as a measure of control in interior-type ponderosa pine areas. (1).

CONTROL RECOMMENDATIONS

Eastern Lassen and Susanville Areas

Selective removal of the high-risk trees from the stands has proved to be a positive, effective method for reducing pine beetle loss and this type of cutting should be extended to as much of the ponderosa pine stands of the reporting areas as possible. In particular, Bogard Buttes, Butte Creek and portions of Stephens Ranch reporting units should be given high priority in any future sales plans. Immediate control action by selective removal of high risk trees is needed along the western portion of the Nigger Spring unit.

Burney Area

Severe winds during the last week of October resulted in rather extensive windthrow and breakage to cutover reserve stands in the Green Burney and Dry Burney areas west of Burney Mountain. This windthrown material provides excellent breeding conditions for the development of western pine beetle broods and presents a dangerous threat to the surrounding timber unless it is utilized or treated before it produces large beetle populations. Prompt salvage of merchantable windthrown trees and the burning of broken tops capable of supporting bark-beetle broods is recommended as a means of reducing the danger of infestation. At the higher elevations, numerous lodgepole pines were blown down or broken off during the windstorm and may furnish favorable host material for the development of mountain pine beetle broods. It is recommended that this blown-down material be treated by burning or with toxic sprays wherever feasible, to prevent the build-up of additional mountain pine beetle broods and the resultant loss of valuable sugar pines which they may subsequently attack.

Westside Lassen Area

In spite of an increase in the loss rate during the past year endemic loss conditions still exist over most of the Westside Lassen Area and control action is not warranted. Insect activity on the Sugar Pine Flat area appears to be maintaining a high current rate of loss; however, there is no indication of an immediate increase in the loss rate and the infestation does not show signs of spreading to adjacent timber. It will be necessary, however, to maintain constant surveillance over insect activity in this area lest the present rate of loss develops into serious outbreaks before control action can be taken.

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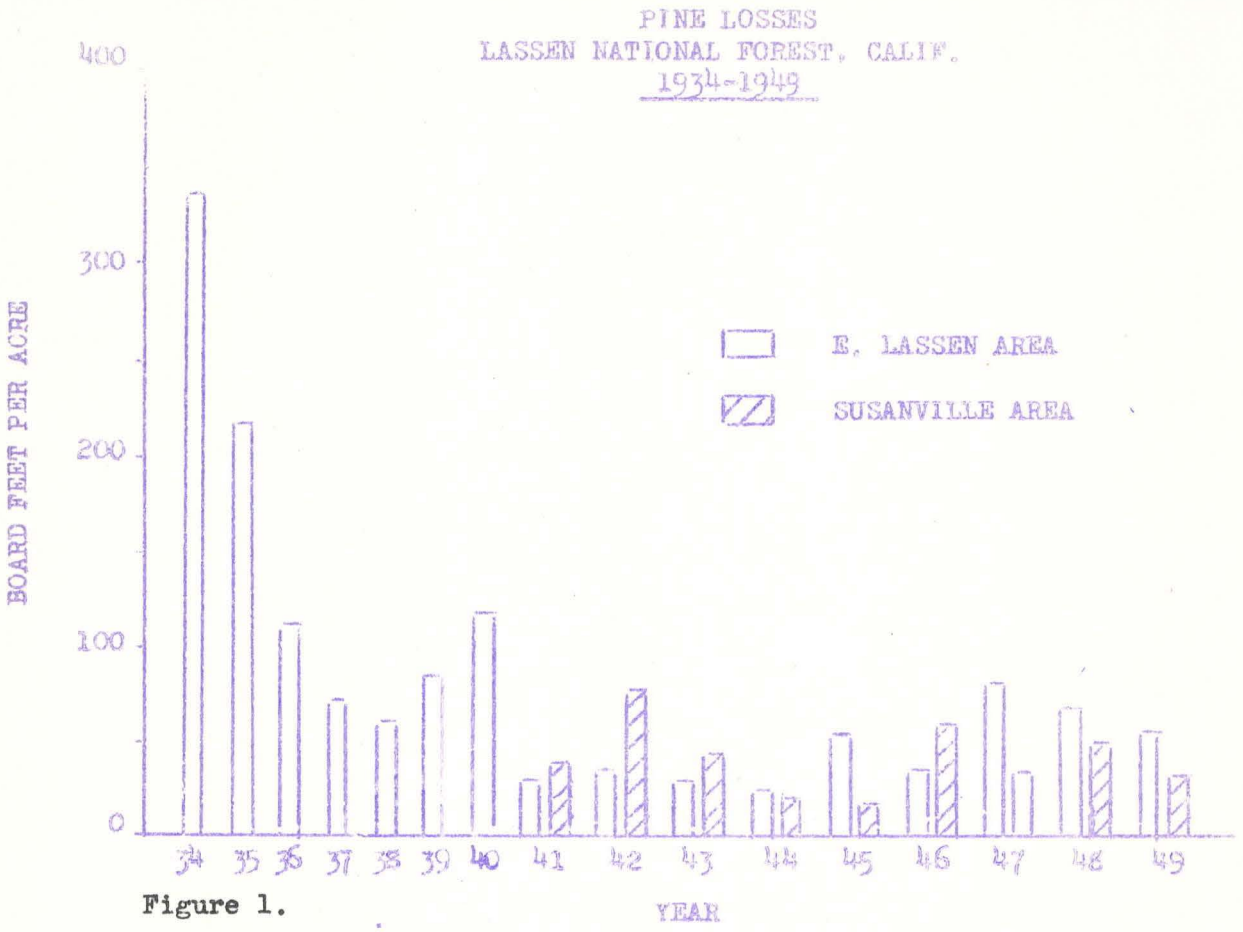

Figure 1.

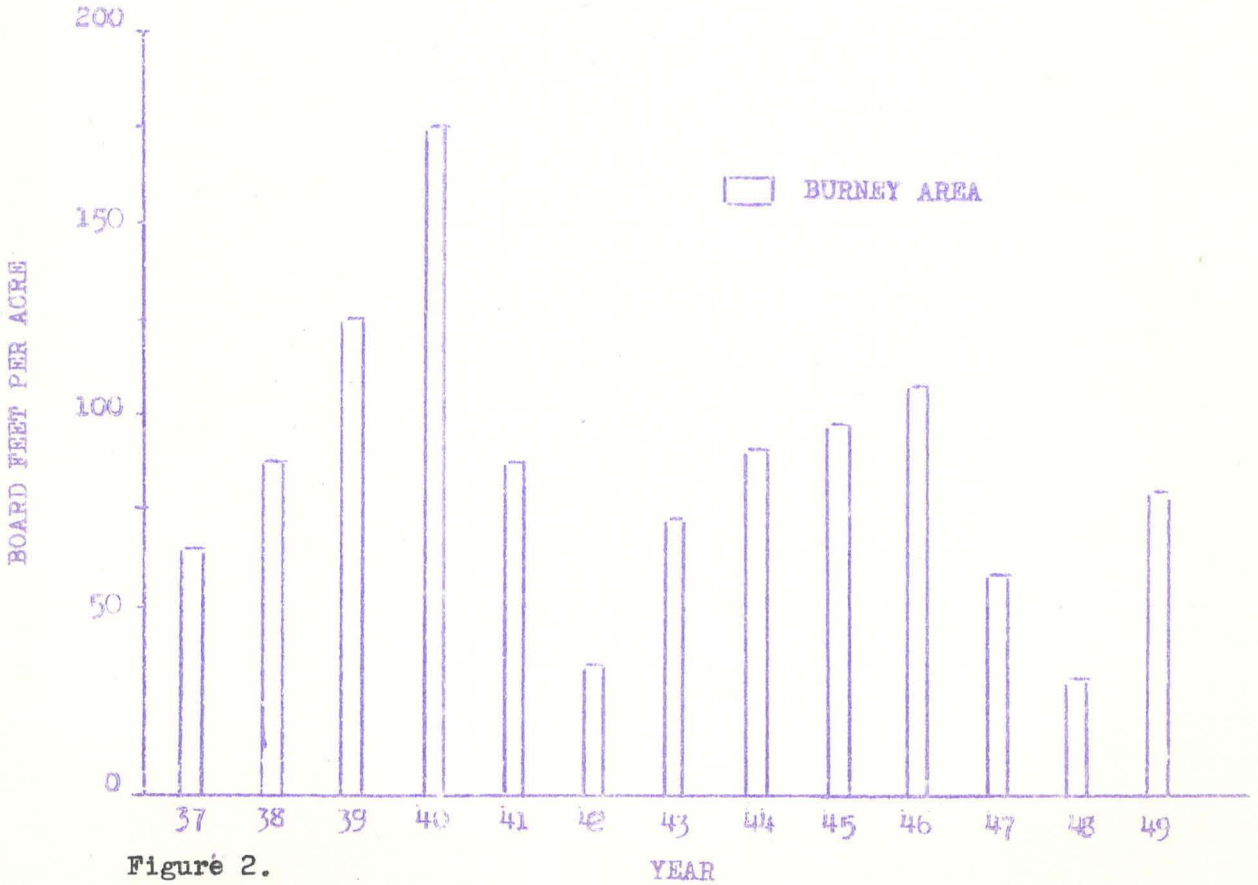

Figure 2.

Table 1. Pine Timber Killed by Bark Beetles on Virgin Sample Plots During 1948 and 1949, Eastern Lassen and Susanville Areas, Lassen County, California

Ento. Unit	Sample Plot No.	Timb'd Acres	Hazard Rating	Pine Stand: Tree Spp.	Pine Stand: Volume M.B.M.	Timber Killed in 1948: No. of Trees	Timber Killed in 1948: Volume (B.M.)	Timber Killed in 1948: Volume p/a	Timber Killed in 1948: Percent of Stand	Pine Timber Killed During 1949: No. of Trees	Pine Timber Killed During 1949: Volume (B.M.)	Pine Timber Killed During 1949: Volume p/a	Pine Timber Killed During 1949: Percent of Stand
EASTERN LASSEN AREA													
Coble Mt.	RD-1	160	V	PP	670	2	720	4.5	0.11	1	960	6.0	0.14
				JP	110	None	None	None	None	None	--	--	--
				Total	780	2	720	4.5	0.09	1	960	6.0	0.12
	RD-2	160	V	PP	670	12	5180	32.4	0.77	5	3830	23.9	0.57
				JP	110	None	--	--	--	None	--	--	--
				Total	780	12	5180	32.4	0.66	5	3830	23.9	0.49
Dixie Valley	RD-25	80	V	PP	370	2	400	5.0	0.11	1	410	5.1	0.11
				JP	270	1	2950	36.9	1.09	None	--	--	--
				Total	640	3	3350	41.9	0.52	1	410	5.1	0.06
Nigger Springs	RD-4	160	IV	PP	40	5	12880	80.5	32.20	None	--	--	--
				JP	1170	2	5140	32.1	0.44	5	7730	48.3	0.66
				Total	1210	7	18020	112.6	1.49	5	7730	48.3	0.64
	RD-5	160	IV	PP	1680	6	6560	41.0	0.39	5	6930	43.3	0.41
				JP	610	None	--	--	--	2	1150	7.2	0.19
				Total	2290	6	6560	41.0	0.29	7	8080	50.5	0.35
	RD-51	160	IV	PP	860	2	2150	13.4	0.25	None	--	--	--
				JP	890	4	5460	34.1	0.61	4	5220	32.6	0.59
				Total	1750	6	7610	47.5	0.43	4	5220	32.6	0.30
	RD-52	160	IV	PP	860	None	--	--	--	1	2020	12.6	0.23
				JP	890	2	2060	12.9	0.23	3	4340	27.1	0.49
				Total	1750	2	2060	12.9	0.12	4	6360	39.7	0.36
	RD-54	160	IV	PP	860	8	8830	55.2	1.02	8	5100	31.9	0.59
				JP	890	1	--	--	--	1	2570	16.1	0.29
				Total	1750	9	8830	55.2	0.50	9	7670	48.0	0.44
	L-6	320	IV	PP	2620	19	8020	25.1	0.31	20	4680	14.6	0.18
				JP	260	None	--	--	--	1	1390	4.3	0.53
				Total	2880	19	8020	25.1	0.28	21	6070	18.9	0.21
Beaver Creek	RD-3	160	IV	PP	780	2	420	4.5	0.05	2	2460	15.4	0.32
				JP	620	1	--	--	--	1	510	3.2	0.08
				Total	1400	3	420	4.5	0.03	3	2970	18.6	0.21
	RD-6	160	III-IV	PP	440	None	--	--	--	4	3280	20.5	0.74
				JP	820	1	6060	37.9	0.76	None	--	--	--
				Total	1260	1	6060	37.9	0.48	4	3280	20.5	0.26
	RD-50	160	IV	PP	610	2	2100	13.1	0.34	3	130	0.8	0.02
				JP	720	6	10270	64.2	1.43	10	10800	67.5	1.50
				Total	1330	8	12370	77.3	0.93	13	10930	68.3	0.82
	L-13	260	IV	PP	1050	13	10490	40.3	0.99	28	21130	81.3	2.01
				JP	260	1	2680	10.3	1.31	4	730	2.8	0.28
				Total	1310	14	13170	50.6	1.05	32	21860	84.1	1.67
Gordon Valley	RD-24	80	III-IV	PP	1600	4	8120	101.5	0.51	2	810	14.3	0.05
				JP	910	None	--	--	--	None	--	--	--
				Total	2510	4	8120	101.5	0.32	2	810	14.3	0.03
	RD-39	72	IV	PP	1600	3	2920	40.6	0.18	CUTOVER			
				JP	910	1	140	1.9	0.02				
				Total	2510	4	3060	42.5	0.12				
Butte Creek	RD-8	160	III	PP	530	2	4000	25.0	0.75	2	3340	20.9	0.63
				JP	1270	3	4990	31.2	0.39	2	1320	8.3	0.10
				Total	1800	5	8990	56.2	0.50	4	4660	29.2	0.26
	RD-9	160	III	PP	360	4	7280	45.5	2.02	6	4840	30.2	1.34
				JP	1410	5	8860	55.4	0.63	4	8870	55.4	0.63
				Total	1770	9	16140	100.9	0.91	10	13710	85.6	0.77
	RD-10	160	III	PP	1690	4	15470	96.7	0.92	1	5040	31.5	0.30
				JP	1280	2	1840	11.5	0.14	2	6210	38.8	0.49
				Total	2970	6	17310	108.2	0.58	3	11250	70.3	0.38
	RD-42	160	IV	PP	610	1	590	3.7	0.10	4	5920	37.0	0.97
				JP	1290	None	--	--	--	3	1510	9.4	0.12
				Total	1900	1	590	3.7	0.03	7	7430	46.4	0.39
	L-12	320	III	PP	1080	7	9300	29.1	0.86	7	7040	22.0	0.65
				JP	2220	3	7580	23.7	0.34	2	4090	12.8	0.18
				Total	3300	10	16880	52.8	0.54	9	11130	34.8	0.34
Halls Flat	RD-7	160	IV	PP	90	1	4000	25.0	4.44	3	7900	49.4	8.77
				JP	1160	4	8420	52.5	0.73	3	4320	27.0	0.37
				Total	1250	5	12420	77.5	0.99	6	12220	76.4	0.98
	RD-29	160	III-IV	PP	620	4	4180	26.1	0.67	2	150	0.9	0.02
				JP	760	None	--	--	--	4	9510	59.4	1.25
				Total	1380	4	4180	26.1	0.30	6	9660	60.3	0.70
Harvey Valley	RD-31	160	IV	PP	2280	8	12300	76.9	0.54	5	9540	59.6	0.42
				JP	220	4	3530	22.1	1.60	None	--	--	--
				Total	2500	12	15830	99.0	0.63	5	9540	59.6	0.38
	L-3	320	III	PP	4130	17	34480	101.8	0.83	28	27070	84.6	0.66
				JP	650	11	15940	49.8	2.45	6	7140	22.3	1.10
				Total	4780	28	50420	151.6	1.05	34	34210	106.9	0.72
Bogard Buttes	RD-11	160	III	PP	470	7	12160	76.0	2.59	4	8890	55.6	1.89
				JP	2060	8	11950	74.7	0.56	5	1980	12.4	0.10
				Total	2530	15	24110	150.7	0.95	9	10870	68.0	0.43
Stephens Ranch	RD-14	160	III	PP	2650	3	6100	38.1	0.23	4	7990	49.9	0.30
Merrill Flat	RD-41	160	III	PP	2330	4	2470	15.4	1.06	4	7940	49.6	0.34
	RD-33	89	III-IV	PP	2340	4	7000	78.7	0.30	2	3930	43.6	0.17
				JP	160	None	--	--	--	None	--	--	--
				Total	2500	4	7000	78.7	0.28	2	3930	43.6	0.16
	RD-34	160	III-IV	PP	1600	None	--	--	--	1	1100	8.6	0.07
				JP	400	None	--	--	--	None	--	--	--
				Total	2000	None	--	--	--	1	1100	8.6	0.06
Blacks Mtn.	L-16	287	III	PP	1620	18	15050	47.0	0.93	23	24730	86.2	1.53
				JP	1410	None	--	--	--	None	--	--	--
				Total	3030	18	15050	47.0	0.50	23	24730	86.2	0.82
	BMEF	1278	IV	PP	19910	105	123330	99.8	0.63	113	135880	106.3	0.68
				JP	1560	5	7340	5.9	0.49	9	8120	6.4	0.52
				Total	21470	110	130670	105.7	0.62	122	144000	112.7	0.67
Total		6466[1/]		PP	60350	269	326500	50.5	0.54	298	313160	49.0	0.53
				JP	26240	65	105210	16.3	0.40	71	87510	13.7	0.34
				Total	86590	334	431710	66.8	0.50	369	400670	62.6	0.48
SUSANVILLE AREA													
Willard Creek	RD-35	160	III-IV	PP	860	2	5600	35.0	0.65	None	--	--	--
				JP	1570	1	980	16.3	0.06	None	--	--	--
				Total	2430	3	6580	51.3	0.27	None	--	--	--
Total		160		PP	860	2	5600	35.0	0.65	None	--	--	--
				JP	1570	1	980	16.3	0.06	None	--	--	--
				Total	2430	3	6580	51.3	0.27	None	--	--	--
Total of E. Lassen and Susanville Areas		6626		PP	61210	271	332100	50.1	0.55	298	313160	47.8	0.52
				JP	27810	66	106190	16.0	0.38	71	87510	13.4	0.32
				TOTAL	89020	337	438290	66.1	0.50	369	400670	61.2	0.46

1/ Less RD-39 in 1949

Table 2. Estimated Virgin Pine Timber Killed by Bark Beetles During 1948 and 1949 in the Eastern Lassen and Susanville Areas. Lassen National Forest, California.

Entomological Units	Virgin Pine Stand (As of Jan. 1, 1949) Acreage	Tree Spp	Vol. MBM	Pine Timber Killed in 1948 No. Trees	Volume M.B.M.	bm/acre	Percent stand	Virgin Pine Stand (As of Jan. 1, 1950) Acreage	Tree Spp	Vol. MBM	Pine Timber Killed in 1949 No. Trees	Volume M.B.M.	bm/acre	Percent stand
EASTERN LASSEN AREA														
Coble Mtn.	18,030	PP	93,050	1028	426	23.6	0.48	18,030	PP	93,050	721	267	14.8	0.29
		JP	9,690	198	85	4.7	0.89		JP	9,690	36	40	2.2	0.41
Dixie Valley	5,850	PP	29,070	146	29	5.0	0.10	5,810	PP	28,880	297	184	31.6	0.64
		JP	14,000	70	216	36.9	1.54		JP	13,900	35	6	1.1	0.05
Nigger Spring	14,830	PP	73,110	237	798	53.8	1.09	14,830	PP	73,110	1780	990	16.7	1.35
		JP	86,320	208	294	19.8	0.34		JP	86,320	415	593	20.0	0.69
Beaver Creek	16,740	PP	113,380	301	243	14.5	0.24	16,740	PP	113,380	837	611	36.5	0.54
		JP	45,060	234	470	28.1	1.04		JP	45,060	335	290	17.3	0.64
Straylor Lake	6,220	PP	43,680	112	341	54.8	0.78	6,140	PP	37,210	279	201	32.7	0.54
		JP	22,670	37	114	18.4	0.50		JP	18,500	112	118	19.2	0.64
Gordon Valley	9,820	PP	85,320	285	386	39.3	0.45	9,570	PP	82,670	545	218	22.8	0.26
		JP	37,400	59	98	10.0	0.26		JP	36,540	182	73	7.6	0.02
Butte Creek	26,540	PP	220,670	504	1061	40.0	0.48	26,540	PP	220,670	1115	1449	54.6	0.66
		JP	117,640	372	648	24.4	0.55		JP	117,640	743	1216	45.8	1.03
Halls Flat	11,150	PP	17,040	513	854	76.6	5.01	11,150	PP	17,040	178	187	16.8	1.09
		JP	75,070	424	585	52.5	0.78		JP	75,070	279	404	36.2	0.54
Blacks Mtn.	20,320	PP	232,720	1585	1670	82.2	0.72	20,320	PP	232,720	1707	1853	91.2	0.80
		JP	87,940	122	73	3.6	0.08		JP	87,940	162	181	8.9	0.20
Harvey Valley	10,870	PP	137,660	370	648	59.6	0.47	10,870	PP	137,660	750	829	76.3	0.06
		JP	18,650	217	261	24.0	1.40		JP	18,650	130	162	14.9	0.87
Cave Mountain	9,760	PP	86,570	283	388	39.8	0.48	9,010	PP	81,330	198	393	43.6	0.48
		JP	24,010	49	6	0.6	0.02		JP	21,100	63	131	14.5	0.62
Bogard Buttes	16,840	PP	190,240	707	1292	76.7	0.68	16,840	PP	190,240	421	871	51.7	0.46
		JP	80,160	556	798	47.4	0.99		JP	80,160	168	69	4.1	0.09
Stephens Ranch	26,600	PP	388,220	1543	2296	86.3	0.59	26,600	PP	388,220	665	1375	51.7	0.35
		JP	11,920	879	1325	49.8	1.11		JP	11,920	266	109	4.1	0.91
Crater Mountain	5,380	PP	73,720	156	195	36.3	0.26	4,660	PP	63,860	116	232	49.8	0.36
		JP	12,880	32	23	4.3	0.18		JP	11,160	19	37	8.0	0.33
Merrill Flat	5,870	PP	64,210	164	231	39.3	0.34	5,870	PP	64,210	70	118	20.2	0.18
		JP	15,260	35	64	10.9	0.42		JP	15,260	18	29	5.0	0.19
		SP	11,480	102	211	30.6	1.83		SP	11,480	51	106	15.3	0.92
Brockman Flat	7,580	PP	4,340	227	398	52.5	9.17	7,400	PP	4,240	163	323	43.6	7.62
		JP	20,660	45	80	10.5	0.39		JP	20,170	44	111	15.0	0.55
Eastern Lassen Area Sub-total	212,400	PP	1,853,000	8161	11256	53.0	0.60	210,380	PP	1,828,490	9742	10101	48.0	0.55
		JP	679,330	3537	5140	24.2	0.76		JP	669,080	3007	3569	17.0	0.53
		SP	11,480	102	211	30.6	1.83		SP	11,480	51	106	15.3	0.92
		TOTAL	2,543,810	11800	16607	78.2	0.65		TOTAL	2,509,050	12800	13776	65.4	0.55
SUSANVILLE AREA														
Merrillville	4,210	PP	36,460	101	160	38.0	0.44	4,210	PP	36,460	97	109	25.9	0.30
		JP	5,170	21	42	10.0	0.81		JP	5,720	25	24	5.7	0.40
Piute Creek	8,310	PP	82,080	199	316	38.0	0.38	8,150	PP	80,510	220	282	34.6	0.35
		JP	9,020	42	83	10.0	0.92		JP	8,920	69	67	8.2	0.75
Susan River	6,210	PP	61,560	80	112	18.0	0.18	5,650	PP	57,110	127	126	22.3	0.22
		JP	22,060	63	93	15.0	0.42		JP	18,960	30	38	6.7	0.20
Robbers Creek	8,720	PP	3,060	58	70	8.0	2.29	8,720	PP	3,060	21	23	2.6	0.75
		JP	135,050	51	57	6.5	0.04		JP	135,050	200	202	23.2	0.15
Coppervale	1,980	PP	19,120	56	63	31.8	0.33	1,980	PP	19,120	67	76	38.4	0.40
		JP	15,070	65	77	38.9	0.51		JP	15,070	62	60	30.3	0.40
Willard Creek	4,210	PP	25,410	26	43	10.2	0.17	4,210	PP	25,410	35	38	9.0	0.15
		JP	22,480	21	34	8.1	0.15		JP	22,480	28	27	6.4	0.12
Mountain Meadows	4,120	PP	30,370	36	48	11.6	0.16	4,120	PP	30,370	52	58	14.1	0.19
		JP	33,860	51	64	15.5	0.19		JP	33,860	59	61	14.8	0.18
Diamond Mountain	18,880	PP	179,710	347	323	17.1	0.18	18,880	PP	179,710	373	377	20.0	0.21
		JP	60,120	101	126	6.6	0.21		JP	60,120	90	96	5.1	0.16
		SP	6,110	7	10	0.6	0.17		SP	6,110	10	11	0.6	0.18
Susanville Area Sub-total	56,640	PP	437,770	903	1135	20.0	0.26	55,920	PP	431,750	992	1089	19.4	0.25
		JP	302,830	415	576	10.2	0.19		JP	300,180	563	575	10.3	0.19
		SP	6,110	7	10	0.6	0.17		SP	6,110	10	11	0.6	0.18
		TOTAL	746,710	1325	1721	30.4	0.23		TOTAL	738,040	1565	1675	30.0	0.23
Total for Eastern Lassen and Susanville Areas	269,040	PP	2,290,770	9064	12391	46.1	0.54	266,300	PP	2,260,240	10734	11190	42.0	0.50
		JP	982,160	3952	5716	21.2	0.58		JP	969,260	3570	4144	15.6	0.43
		SP	17,590	109	221	0.9	0.13		SP	17,590	61	117	0.5	0.07
		TOTAL	3,290,520	13125	18328	68.1	0.56		TOTAL	3,247,090	14365	15451	58.0	0.48

Table 3. Pine Timber Killed by Bark Beetles During 1948 and 1949 on Sample Plots in Areas Cut by Sanitation-Salvage Methods. Eastern Lassen and Susanville Areas, Lassen National Forest.

Ento. Unit	Sample Plot No.	Timb'd Acres	Hazard Rating	Pine Stand Tree Spp.	Pine Stand Volume M.B.M.	Timber Killed in 1948 No. of Trees	Timber Killed in 1948 Volume (B.M.)	Timber Killed in 1948 Volume p/a	Timber Killed in 1948 Percent of Stand	Timber Killed During 1949 No. of Trees	Timber Killed During 1949 Volume (B.M.)	Timber Killed During 1949 Volume p/a	Timber Killed During 1949 Percent of Stand
EASTERN LASSEN AREA													
Dixie Valley	RD-20	96	V	PP	160	2	900	9.4	0.56	None	--	--	--
				JP	350	None	--	--	--	None	--	--	--
	RD-21	80	V	PP	550	None	--	--	--	5	1340	16.8	0.24
Gordon Valley	RD-23	160	III	PP	3210	5	3110	19.4	0.10	7	2410	15.1	0.08
				JP	550	1	440	2.8	0.08	1	980	6.1	0.18
Harvey Valley	RD-27	80	IV	PP	870	7	450	5.6	0.05	Not cruised			
Bogard Buttes	RD-13	160	III	PP	3150	1	530	3.3	0.02	3	170	1.1	0.005
Crater Mtn.	RD-30	152	III-IV	PP	2300	None	--	--	--	3	810	5.3	0.04
Merrill Flat	RD-32	160	IV	PP	1660	None	--	--	--	9	1030	6.4	0.06
Cave Mtn.	RD-28	160	IV-V	PP	1920	1	80	0.5	0.004	4	1830	11.4	0.10
Straylor Lake	RD-16	160	IV	PP	450	None	--	--	--	6	1800	11.2	0.40
Blacks Mtn.		1463	IV	PP	18681	41	29960	20.4	0.16	41	39050	26.7	0.21
				JP	1812	1	940	0.6	0.05	4	6830	4.7	0.38
Area Totals		2671		PP	32951	57	35030	13.1	0.11	78*	48440	18.7	0.15
				JP	2712	2	1380	0.5	0.05	5	7810	3.0	0.29
SUSANVILLE AREA													
Willard Creek	RD-40	128	III	PP	906	4	1260	13.3	0.14	10	5340	41.7	0.59
				JP	546	None	--	--	--	1	100	0.8	0.02
Merrill-ville	RD-38	160	III	PP	1560	None	--	--	--	2	1060	6.6	0.07
Area Totals		288		PP	2466	4	1260	4.4	0.05	12	6400	22.2	0.26
				JP	546	None	--	--	--	1	100	0.3	0.02
Total Eastern Lassen and Susanville Areas		2965		PP	35417	61	36290	12.2	0.10	90*	54840	19.0	0.15
				JP	3258	2	1380	0.5	0.03	2	7900	2.7	0.24
				TOTAL	28675	63	37670	12.7	0.10	92	62740	21.7	0.17

* Less RD-27

Table 4. Coniferous Timber Killed by Bark Beetles on Virgin Sample Plots During 1948 and 1949, Burney Area, Shasta County, California.

Ento. Unit	Sample Plot No.	Timb'd Acres	Hazard Rating	Timber Stand: Tree Spp.	Timber Stand: Volume M.B.M.	Timber Killed During 1948: No. of Trees	Timber Killed During 1948: Volume (B.M.)	Timber Killed During 1948: Vol./a	Timber Killed During 1948: Percent of Stand	Timber Killed During 1949: No. of Trees	Timber Killed During 1949: Volume (B.M.)	Timber Killed During 1949: Vol./a	Timber Killed During 1949: Percent of Stand
Burney Flat	RD-91	220	III-IV	PP	1969	21	13680	62.2	0.69	8	12660	57.5	0.64
	RD-92	128	III-IV	PP	1145	2	780	6.1	0.15	7	5670	44.3	0.50
	RP-6	20	IV	PP	177	2	2920	146.0	1.65	Not cruised			
	RP-9	20	IV	PP	180	None	--	--	--	Not cruised			
	SP-4	240	III-IV	PP	2148	19	19890	82.8	0.92	28	35350	147.3	1.64
	SP-6	160	III	PP	1446	3	4360	27.2	0.30	5	3900	24.4	0.27
	SP-9	290	III	PP	2620	7	5930	20.4	0.23	6	7190	24.8	0.27
	SP-11	280	III	PP	2292	18	13950	49.8	0.61	25	22120	79.0	0.96
	SP-12	320	III-IV	PP	2864	19	20710	64.7	0.72	29	26660	83.3	0.93
	SP-13	320	IV	PP	2836	8	8250	25.8	0.29	21	16860	52.7	0.59
	SP-14	320	IV	PP	2836	18	15340	47.9	0.54	40	34850	108.9	1.23
Goose Valley	RD-88	104	II	PP	903	None	--	--	--	None	--	--	--
				SP	36	None	--	--	--	2	4510	43.4	1.25
				WF	1233	1	1050	10.0	0.08	2	2370	22.8	0.19
	RD-89	40	II	PP	694	None	--	--	--	2	5190	129.7	0.75
				SP	14	None	--	--	--	1	11510	287.7	82.2
				WF	413	None	--	--	--	1	2370	59.2	0.57
	RD-90	72	II	PP	625	1	1740	24.1	0.28	9	3230	46.1	0.52
				SP	94	None	--	--	--	1	30	0.4	0.03
				WF	567	1	660	9.2	0.12	5	4960	71.8	0.87
	RD-96	40	III	PP	578	--	--	--	--	10	6310	157.7	1.09
				SP	216	--	--	--	--	4	18740	468.5	8.67
Dry Lake	RD-10	60	II	PP	1002	None	--	--	--	Not cruised			
				SP	600	1	340	5.7	0.06				
				WF	838	1	4310	71.8	0.51				
	RD-80	120	III	PP	1241	1	6210	52.8	0.50	5 1/	3120	37.6	0.25
				SP	725	None	--	--	--	None	--	--	--
				WF	908	None	--	--	--	9	12060	145.3	1.33
	RD-81	152	II-III	PP	2056	None	--	--	--	8	8600	56.5	0.42
				SP	538	None	--	--	--	None	--	--	--
				WF	1644	1	330	2.2	0.02	15	6470	42.6	0.39
	RD-99	116	III	PP	2061	--	--	--	--	11	6020	51.9	0.29
				SP	553	--	--	--	--	None	--	--	--
				WF	2001	--	--	--	--	5	2240	19.3	0.11
Doyle Butte	RP-13,16	40	III	PP	429	None	--	--	--	Not cruised			
	RP-15,17	30	IV	PP	206	2	1580	52.7	0.77	Not cruised			
	RD-120	66	IV	PP	367	--	--	--	--	5	730	11.1	0.20
				SP	101	--	--	--	--	2	2150	32.6	2.13
				WF	34	--	--	--	--	None	--	--	--
Thousand Lakes	RD-82	304	III	PP	2915	2	2760	9.1	0.10	11 2/	11210	36.9	0.38
				SP	941	None	--	--	--	None	--	--	--
				WF	1181	1	1170	3.8	0.10	2	2160	7.1	0.18
	RD-83	160	III	PP	1715	1	540	3.4	0.03	6 3/	12560	79.3	0.73
				WF	297	None	--	--	--	2 4/	2690	16.8	0.90
	RD-84	253	III	PP	2930	1	540	2.1	0.02	3	3670	14.5	0.17
				JP	541	1	2380	10.2	0.44	1	1180	6.3	0.30
				WF	548	None	--	--	--	1 5/	780	4.2	0.19
	RD-85	216	III	PP	2315	4	3310	15.3	0.14	17	31140	144.2	1.34
				WF	1253	2	2970	13.8	0.24	5 6/	4800	22.2	0.38
	RD-86	120	III	PP	1286	None	--	--	--	8	10290	85.7	0.80
				SP	495	2	3400	28.3	0.69	2	5290	44.1	1.07
				WF	556	None	--	--	--	4	10840	90.3	1.94
	RP-19,20, 22	60	III	PP	642	None	--	--	--	Not cruised			
	RP-21,25	40	II	PP	628	None	--	--	--	Not cruised			
Hat Creek	RD-17	416	III	PP	4459	2	4460	10.7	0.10	Not cruised			
				SP	1110	5	19050	45.8	1.72				
	RD-100	54	IV	PP	575	--	--	--	--	1	470	8.7	0.08
	RP-18,23, 24	60	IV	PP	582	None	--	--	--	Not cruised			
	RP-26	20	III	PP	214	None	--	--	--	Not cruised			
Big Springs	RD-104	73	II	PP	618	--	--	--	--	None			
	RD-105	46	II	PP	389	--	--	--	--	None			
				JP	133	--	--	--	--	2	390	8.5	0.29
				WF	561	--	--	--	--	2	2330	50.6	0.41
	RD-106	240	III	PP	3128	2	670	2.8	0.02	8	23910	99.6	0.76
				JP	542	None	--	--	--	4	6770	28.2	1.25
	RD-107	344	III	PP	4483	8	10520	30.6	0.23	12	26830	78.0	0.60
				JP	776	None	--	--	--	3 7/	3430	10.0	0.44
	RD-108	320	III	PP	4170	3	4650	14.5	0.11	9	10480	65.5	0.50
				JP	161	None	--	--	--	1	1720	10.8	2.12
				WF	676	1	3270	10.2	0.48	2	1180	7.4	0.35
	RD-109	224	III	PP	2919	1	4140	18.5	0.14	3	7290	32.4	0.25
				JP	506	None	--	--	--	4	6360	28.3	1.26
				WF	620	None	--	--	--	2	3460	15.4	0.56
	RP-27,28, 29	60	III	PP	781	None	--	--	--	Not cruised			
	RP-30,31, 32	60	III	PP	781	1	2100	60.0	0.27	Not cruised			
	RP-34,37	40	III	PP	521	None	--	--	--	Not cruised			
	RP-33,35, 38	60	II	PP	681	None	--	--	--	Not cruised			
Total for Burney Area	1948	5720		PP	60525	146	149030	26.0	0.25				
				JP	2526	1	2380	1.7	0.09				
				SP	4553	8	22790	16.4	0.50				
				WF	10734	8	13760	6.4	0.13				
		PP + JP + SP			67604	155	174200	30.4	0.26				
	1949	5013		PP	52901					297	336310	67.1	0.64
				JP	2436					15	19850	16.5	0.81
				SP	3489					12	42910	39.1	1.23
				WF	11731					57	58890	28.7	0.50
		PP + JP + SP			58826					324	399070	79.6	0.68

1/ RD-80 loss computed on basis of 83 acres as of 1/1/49
2/ RD-82 loss computed on basis of 256 acres as of 1/1/50
3/ RD-83 loss computed on basis of 80 acres as of 1/1/50
4/ RD-84 loss computed on basis of 168 acres as of 1/1/50
5/ RD-85 loss computed on basis of 200 acres as of 1/1/50
6/ RD-86 loss computed on basis of 104 acres as of 1/1/50
7/ RD-108 loss computed on basis of 160 acres as of 1/1/50

Table 5. Estimated Virgin Timber Killed by Bark Beetles in 1948 and 1949, Burney Area, Shasta County, California.

Entomological Units	Virgin Timber Stand (As of Jan. 1, 1949) Acreage	Tree Spp	Vol. MBM	Timber Killed in 1948 No. Trees	Volume M.B.M.	bm/acre	Percent stand	Virgin Timber Stand (As of Jan. 1, 1950) Acreage	Tree Spp	Vol. MBM	Timber Killed in 1949 No. Trees	Volume M.B.M.	bm/acre	Percent stand
Burney Flat	19,223	PP	167,716	961	878	45.7	0.52	19,223	PP	167,716	1422	1394	72.5	0.83
		SP	94	3	2	0.1	2.13		SP	94	5	3	0.2	3.19
Goose Valley	21,250	PP	249,194	170	324	15.2	0.13	21,250	PP	249,194	1742	1222	57.5	0.49
		SP	99,588	51	110	5.2	0.11		SP	99,588	659	2888	135.9	2.90
		WF	163,123	128	115	5.4	0.07		WF	163,123	659	808	38.0	0.49
Dry Lake	16,954	PP	241,893	136	178	10.5	0.07	16,674	PP	237,867	917	842	50.5	0.35
		SP	55,312	51	30	1.8	0.05		SP	54,603	67	82	4.9	0.15
		WF	100,967	102	124	7.3	0.12		WF	99,465	1384	987	59.2	0.99
Doyle Butte	12,170	PP	118,039	134	136	11.2	0.12	12,170	PP	118,039	669	741	60.9	0.63
		SP	27,199	11	16	1.3	0.06		SP	27,199	73	64	5.3	0.27
		WF	25,608	24	33	2.7	0.13		WF	25,608	122	146	12.0	0.57
Thousand Lakes	34,526	PP	526,447	276	252	7.3	0.05	34,486	PP	525,599	1966	2990	86.7	0.57
		SP	89,542	69	131	3.8	0.14		SP	89,409	207	224	6.5	0.25
		WF	254,003	104	159	4.6	0.06		WF	253,641	621	907	26.3	0.36
Hat Creek	11,729	PP	117,216	35	84	7.2	0.07	11,729	PP	117,216	727	602	51.3	0.51
		SP	21,297	129	427	36.4	2.00		SP	21,297	211	389	33.2	1.83
		WF	21,934	110	141	12.0	0.64		WF	21,934	211	568	48.4	2.59
Big Springs	43,905	PP	527,946	176	680	15.5	0.13	43,905	PP	527,946	1844	3517	80.1	0.67
		SP	50,524	59	131	2.6	0.25		SP	50,524	118	262	5.2	0.52
		WF	282,387	44	101	2.3	0.04		WF	282,387	263	281	6.4	0.10
Total of Burney Area	150,757	PP	1,948,451	1888	2532	15.9	0.13	159,437	PP	1,943,577	9287	11308	70.9	0.58
		SP	343,556	373	847	5.3	0.25		SP	342,716	1340	3912	24.5	1.14
		WF	848,022	512	673	4.2	0.08		WF	846,158	3260	3697	26.4	0.44
	Total Pine		2,292,007	2261	3379	21.2	0.15			2,286,293	10627	15220	95.4	0.67

Table 6. Pine Timber Killed by Bark Beetles During 1948 and 1949 on Sample Plots in Areas Cut by Sanitation-Salvage Methods. Burney Area, Lassen and Shasta National Forests.

Ento. Unit	Sample Plot No.	Timb'd Acres	Hazard Rating	Pine Stand		Pine Killed in 1948				Pine Killed in 1949			
				Tree Spp.	Volume M.B.M.	No. of Trees	Volume (B.M.)	Vol./a	Percent of Stand	No. of Trees	Volume (B.M.)	Vol./a	Percent of Stand
Burney Flat	SP-1	320	III-IV	PP	2762	12	8380	26.2	0.32	28	19140	59.8	0.69
	SP-2	320	III	PP	2132	11	2590	8.1	0.12	29	17180	53.7	0.81
	SP-3	320	III-IV	PP	2315	14	9570	29.9	0.41	41	28580	89.3	1.23
	SP-5	320	III	PP	2747	6	9890	30.9	0.36	16	5630	17.6	0.20
	SP-6	160	III	PP	1275	1	1470	9.2	0.12	9	2940	18.4	0.23
	SP-10	320	IV	PP	2791	11	4740	14.8	0.17	19	8380	26.2	0.30
	RD-91	100	III-IV	PP	891	8	2310	23.1	0.26	7	4960	49.6	0.56
Dry Lake	RD-80	43	II	PP	377	1	3400	79.0	0.90	None	--	--	--
Big Springs	RD-106	80		PP	954	1	140	1.8	0.01	5	7150	89.3	0.75
Total for Burney Area		1983	III	PP	16244	65	42490	21.3	0.26	154	93960	47.4	0.56

Table 7. Coniferous Timber Killed During 1948 and 1949 by Bark Beetles on Virgin Sample Plots. West Lassen Area, Lassen National Forest and Adjacent Timberlands.

Working Circle	Sample Plot No.	Timb'd Acres	Tree Species	Trees Killed in 1948			Trees Killed in 1949		
				No. of Trees	Volume B.M.	Vol./a	No. of Trees	Volume B.M.	Vol./a
Western Lassen	RD-63	160	PP	None			None		
			SP	None			1	2580	16.1
	RD-67	40	PP	None			None		
			SP	1	160	4.0	None		
			WF	None			2	3500	87.5
	RD-68	160	PP	2	3530	22.0	1	370	2.3
	RD-69	160	PP	2	2470	15.4	None		
			SP	None			1	6220	38.9
	RD-70	80	PP	None			None		
			SP	None			None		
	RD-71	80	PP	2	2510	31.4	2	490	6.1
			SP	None			5	520	6.5
	RD-73	216	PP	3	6770	31.3	9	43680	202.2
			SP	8	19580	90.6	11	53450	247.4
			WF	7	7440	34.4	15	26390	122.2
	RD-118	92	PP	No record			10	7450	81.0
			SP	No record			10	2310	25.1
			WF	No record			6	3980	43.3
Almanor	RD-64	80	PP	1	1440	18.0	None		
			SP	None			None		
Strips in timberlands adjacent to working circles	RD-55	160	PP	2	9010	56.3	1	250	3.1
			SP	None			4	13150	93.7
			WF	None			None		
	RD-56	160	PP	None			None		
			SP	None			1	140	0.9
			WF	None			None		
	RD-57	80	PP	1	440	5.5	Abandoned		
	RD-58	160	PP	None			None		
			SP	None			None		
			WF	None			1	740	4.6
	RD-59	135	PP	None			2	170	1.2
			WF	None			1	1100	8.1
	RD-60	80	PP	2	19630	245.3	None		
			SP	None			1	3700	46.2
	RD-61	80	PP	None			None		
			SP	None			None		
	RD-72	160	PP	2	6060	37.9	None		
			SP	None			3	15840	99.0
	RD-74	160	PP	8	9120	57.0	1	770	4.8
			SP	1	340	2.1	None		
			WF	1	160	1.0	None		
Total for West Lassen	1948	2151	PP	25	60980	28.3	26*	53180	24.6
			SP	10	20080	11.5	37	97910	53.4
			WF	8	7600	7.4	25	35710	31.8

* 2163 acres cruised in 1949

Table 8. Estimated Virgin Coniferous Timber Killed by Bark Beetles During 1948 and 1949, Western Lassen Area, Lassen National Forest and Adjacent Timberlands.

Working Circle	Virgin Timber Stand (As of Jan. 1, 1949) Acreage	Tree Spp	Vol. MBM	Timber Killed in 1948 No. Trees	Volume M.B.M.	bm/acre	Percent stand	Virgin Timber Stand (As of Jan. 1, 1950) Acreage	Tree Spp	Vol. MBM	Timber Killed in 1949 No. Trees	Volume M.B.M.	bm/acre	Percent stand
Western Lassen	34,800	PP	172,370	348	592	17.0	0.34	33,690	PP	170,690	741	1277	37.9	0.75
		SP	205,940	348	766	22.0	0.37		SP	202,790	1145	1924	57.1	0.95
		WF	284,730	278	289	8.3	0.10		WF	279,340	1684	2358	70.0	0.84
Almanor	63,870	PP	277,540	639	1239	19.4	0.45	63,870	PP	277,540	702	1820	28.5	0.66
		SP	345,270	511	1258	19.7	0.36		SP	345,270	1661	4056	63.5	1.17
		WF	472,510	447	498	7.8	0.10		WF	472,510	1214	1086	17.0	0.23
Magalia	36,100	PP	152,440	397	1022	28.3	0.67	36,100	PP	152,440	433	888	24.6	0.58
		SP	146,940	180	336	9.3	0.23		SP	146,940	614	1632	45.2	1.11
		WF	229,940	144	126	3.5	0.05		WF	229,940	433	596	16.5	0.26
Total for Western Lassen	134,770	PP	602,350	1384	2853	21.2	0.47	133,660	PP	600,670	1876	3985	29.8	0.66
		SP	698,150	1039	2360	17.5	0.34		SP	695,000	3420	7612	56.9	1.10
		WF	987,180	869	913	6.8	0.09		WF	981,790	3331	4040	30.2	0.41
	Total Pine		1,300,500	2423	5213	38.7	0.40			1,295,670	5296	11597	86.8	0.89

Area recommended for control

LEGEND

- Pine Timber Type
- Cutover Land, as of 1/1/50
- Boundary Lines
  - Working Circle Areas
  - Entomological Reporting Areas
  - Entomological Units
- Ground Samples
  - 13 Plot
  - (45) Roadside Strips
  - (82) Trail Strips

T.36N. T.35N. T.34N. T.33N. T.32N. T.31N. T.30N. T.29N. T.28N. T.27N. T.26N. T.25N. T.24N.

R.4W. R.3W. R.2W. R.1W. R.1E. R.2E. R.6E. R.7E. R.8E. R.9E. R.10E. R.11E. R.12E. R.13E.

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

FOREST INSECT SURVEY

LASSEN NATIONAL FOREST, CALIFORNIA
and ADJACENT PRIVATE LANDS

SEASON OF 1950

SCALE MILES
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